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MILITARY (OTS ETC) SPECIFICATION FOR THE CABLE TEST SET, TIME D--ETC(U)

DEC 79 B F PAIZ, A L SIMMONS

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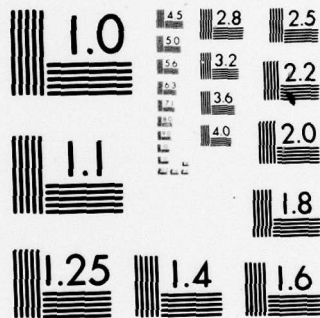
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Publication 1574-01-1-2078

**MILITARY (OTS ETE) SPECIFICATION  
FOR THE  
CABLE TEST SET, TIME DOMAIN  
REFLECTOMETER (TDR)**

December 1979

Prepared for  
U.S. ARMY COMMUNICATIONS AND ELECTRONICS  
MATERIEL READINESS COMMAND  
FORT MONMOUTH, NEW JERSEY  
under Contract DAAB07-78-A-6606

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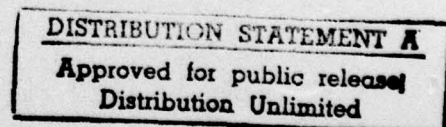
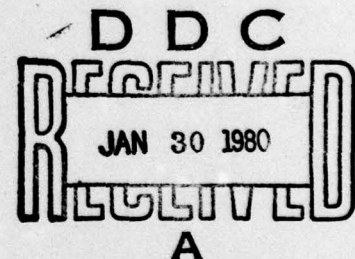


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Prepared for  
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by  
Benjamin F. Paiz  
Albert L. Simmons



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a Subsidiary of Aeronautical Radio, Inc.  
2551 Riva Road  
Annapolis, Maryland 21401  
Publication 1574-01-1-2078

## MILITARY (OTS ETE) SPECIFICATION

This specification is approved for use by the Communications Research and Development Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification defines a Cable Test Set, Time Domain Reflectometer (TDR), hereinafter called the equipment.

1.2 Classification. The equipment defined by this specification shall be Type II, Class 3, Style E, Color R per MIL-T-28800 and ~~as herein stated,~~ with the convertible/rack-mountable capability.

## 2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bids, or the request for proposal, form a part of this specification to the extent specified herein.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Communications Research and Development Command, Fort Monmouth, New Jersey 07703 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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## SPECIFICATIONS

## MILITARY

MIL-T-28800 Test Equipment for Use with Electrical and Electronic Equipment, General Specification for

## STANDARDS

## MILITARY

MIL-STD-461 Electromagnetic Interference Characteristics, Requirements for Equipments

MIL-STD-462 Electromagnetic Interference Characteristics, Measurement of

MIL-STD-781B Reliability Tests, Exponential Distribution

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 3. REQUIREMENTS

3.1 Classification of requirements. The requirements for the equipment are classified as follows:

<u>REQUIREMENT</u>	<u>PARAGRAPH</u>
Safety	3.2
Parts, materials and processes	3.3
Design and construction	3.4
Electrical power sources and connections	3.5
Dimensions and weight	3.6
Enclosure requirements	3.7
Marking and identification	3.8
Environmental requirements	3.9
Reliability requirements	3.10
Performance characteristics	3.11

3.2 Safety. Unless otherwise specified herein, the equipment shall comply with the Type II safety requirements specified in MIL-T-28800.

3.3 Parts, materials and processes. Unless otherwise specified herein, the equipment shall comply with the Type II parts, materials and processes requirements of MIL-T-28800.

3.3.1 Restricted materials. Equipment shall comply with the restricted material requirements of MIL-T-28800 including the requirement for mercury or radioactive materials and shall contain no combination of materials which cause deterioration of any material contained in the equipment due to effects of outgassing.

3.4 Design and construction. Unless otherwise specified herein, the equipment shall comply with the Type II, Class 5, Style E, Color R, design and construction requirements of MIL-T-28800 with the convertible/rack-mountable capability.

3.4.1 First article. When specified, the contractor shall furnish five sample equipments for first article inspection and approval. (See 4.3 and 6.2)

3.4.2 Mainframe plug-in concept. Equipment utilizing externally accessible, externally removable subassemblies (mainframe plug-in concept) do not meet the requirements of this specification and therefore are unacceptable. Items using this concept may be offered, provided the plug-in(s) shall not be removable by access through the front panel or rear panel with the unaided hand. A system part number shall be assigned to any such mainframe plug-in combination required to meet the requirements of this specification. The system part number shall be marked on the mainframe identification plate and any plug-in(s).

3.4.3 Controls. Unless otherwise specified herein, built-in adjustments and compensating devices shall not be externally accessible.

3.4.3.1 Front panel controls. All controls which are required to operate the equipment throughout its specified performance characteristics shall be located on the front panel.

3.4.4 Accessibility. The equipment shall be constructed so that:

3.4.4.1 Subassemblies and chassis components can be removed without removing any other hard wired subassembly, printed circuit card or component.

3.4.4.2 Adjustments can be made without removing any component, printed circuit card or subassembly, except the use of extender cards is permitted.

3.4.4.3 Printed circuit cards can be removed without the need to unsolder cables and interconnecting wiring (connections to all printed circuit cards shall be through pin and socket connectors). Printed circuit cards (mother boards) designed primarily to distribute power and signals to other printed cards (daughter boards) are excluded from this requirement. When such mother boards are used, they shall be accessible from both sides to allow maintenance testing.

3.4.4.4 Indicator lights. Unless approved by the procuring activity upon presentation of acceptable reliability data, indicator lights other than light emitting diodes (LEDs) shall be accessible from the operator's side of the front panel.

3.4.4.5 Encapsulation and embedment. Encapsulation and embedment (potting) of the subassemblies shall not be used.

3.4.5 Solid State construction. Unless otherwise specified herein, the equipment shall be of solid-state, modular, miniaturized construction.



**3.5 Electrical power sources and connections.** Unless otherwise specified herein, the equipment shall comply with the Type II electrical power sources and connections requirements of MIL-T-28800. The equipment shall operate from a nominal 115 volts, single phase, 50, 60 and 400 Hz source. The equipment shall also be capable of operation from internal rechargeable battery source with a minimum of 5 hours continuous operation before recharge.

**3.5.1 Maximum power.** The maximum power consumption of the equipment shall be 40 watts.

**3.5.2 Input power selection device.** An input power selection device shall be provided for selection of input power voltages of 115 Vac or 230 Vac. Provision shall be incorporated to prevent accidental switching. When the equipment is delivered, the power selection device shall be in the 115 Vac position.

**3.5.3 Fuses and circuit breakers.** Fuses and circuit breakers shall be in accordance with MIL-T-28800. (115 Vac/230 Vac) Either common or separate fuseholders may be provided. If only one fuseholder is used (common), the equipment shall be provided with the 115 Vac fuse installed and the 230 Vac fuse shall be stowed with the accessories.

**3.5.4 Input power switch.** A front panel mounted power switch shall be provided. A front panel device shall be provided to indicate "power on" condition. The switch shall break both sides of the power source.

**3.6 Dimensions and weight.**

**3.6.1 Dimensions.** The overall dimensions shall be 330 mm/13" maximum height, 457 mm/18" maximum depth and maximum width of 305 mm/12" or as specified in MIL-T-28800 for rack-mounted equipment. A blank plate may be required to satisfy incremental height requirements.

**3.6.2 Weight.** The maximum weight of the equipment shall be 9 kg/19.8 lbs.

**3.7 Enclosure requirements.** Unless otherwise specified herein, the equipment shall comply with the Style E enclosure requirements of MIL-T-28800.

**3.8 Marking and identification.** Unless otherwise specified herein, the equipment shall comply with the Type II marking and identification requirements of MIL-T-28800.

**3.8.1 Supplemental identification plate.** The supplemental identification plate specified in MIL-T-28800 shall contain the following data only:

- a. Nomenclature
- b. Procurement instrument identification number (PIIN)
- c. Serial number
- d. National stock number
- e. US



3.9 Environmental requirements. Unless otherwise specified herein, the equipment shall comply with the Class 3 environmental requirements of MIL-T-28800.

3.9.1 Electromagnetic interference. The equipment shall comply with the following emission and susceptibility requirements of Notice 4, MIL-STD-461:

CE02	CS02	RE02.1	RS03
CE04	CS06	RE02	

RE02.1 and RS03 shall be performed from (To Be Determined, TBD\*), with RS03 at a susceptibility level of one volt per meter (1 V/m).

3.9.2 Humidity. The equipment shall meet the humidity requirements in accordance with the test specified in paragraph 4.5.5.1.1.3 of MIL-T-28800.

3.9.3 Vibration. The equipment shall comply with the Class 5 vibration requirements of MIL-T-28800, except that the equipment need not be operating during vibration.

3.10 Reliability requirements.

3.10.1 Reliability burn-in. Each equipment delivered against this specification shall be subjected to a minimum 96-hour on-time burn-in procedure as specified in 4.4.4. The last 24 hours of burn-in shall be failure free.

3.10.2 Reliability. Reliability shall comply with requirements as specified herein. The specified MTBF shall be 1500 hours when tested as specified in 4.4.4. A failure shall be as defined in MIL-STD-781B, and as any departure from the required performance or operation of the required accuracies (not correctable by normal use of the operating controls) after the test is initiated. Test Level B, MIL-STD-781 shall be the required test level.

3.10.3 Maintainability requirements. The equipment shall comply with the Type II maintainability requirements of MIL-T-28800. (See 6.4)

3.11 Performance characteristics.

3.11.1 Cable measurement. The equipment shall be capable of displaying cable fault characteristics in cable lengths from 10 to 50,000 feet, with an accuracy of  $\pm 3$  percent of the cable fault location.

3.11.1.1 Test pulse. The equipment shall produce a 1/2 sine positive-going test pulse, selectable in 10, 100, and 1,000 nanosecond ranges, with an accuracy of  $\pm 20$  percent of the pulse width at the 3 dB level.

3.11.1.2 Test pulse amplitude. The test pulse amplitude shall be at least 10 volts unterminated and 5 volts terminated with an accuracy of  $\pm 20$  percent.

\*All TBD items in this specification must be completed by CERCOM/CORADCOM prior to official U.S. Army approval and publication.

3.11.1.3 Scale multiplier. The equipment shall incorporate a scale multiplier to multiply the horizontal scale factors by 1, 10, and 100, calibrated to cable distance in feet. The accuracy shall be  $\pm 2$  percent of the reading plus 1 digit on the dial.

3.11.1.4 Feet/division control. The feet/division control shall be selectable for .5 to 50 feet/division with the multiplier at X1, 5 to 500 feet/division with the multiplier at X10, and 50 to 5,000 feet/division with the multiplier at X100, with an accuracy of  $\pm 2$  percent of the reading plus 1 digit on the dial.

3.11.1.5 Cable dielectric scales ( $V_p/V_{air}$ ). The equipment shall have a variable dielectric scale calibrated to match cable propagation velocity that extends from 0.31 to 1.0 ( $V_p/V_{air}$ ).

3.11.2 Readout Method. The equipment shall use a Cathode Ray Tube (CRT) to display the test pulse reflections over the operator-selected reference level. The horizontal display shall be calibrated in cable distance units, and the vertical axis shall be proportional to the amplitude of the reflected signal. When specified by the procuring activity, a chart recorder shall be provided which shall allow a "hard copy" record of the cable signature. The chart recorder parameters shall meet the environmental requirements of Type II Class 5, Style E, Color R, per MIL-T-28800.

3.11.3 Input/Output Impedance. The input and output impedance of the equipment shall permit cable terminations with impedances of 50, 75, 93, and 125 ohms. The terminating impedance shall not exceed  $\pm 3$  percent of nominal value.

3.11.4 Reflected Amplitude. The equipment shall, at a minimum, measure the reflected amplitude of the test pulse from -78 dBm to 0 dBm in -60, -50, -40, -30, -20, and -10 dBm steps with a variable 0-18 dBm additive vernier.

3.11.5 Primary Connectors. The primary connectors shall be type BNC.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspections required herein are classified as in a and b.

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.3).



4.3 First article and quality conformance inspection. Unless otherwise specified herein, the first article and quality conformance inspections shall be in accordance with MIL-T-28800.

4.3.1 Test plan. Unless otherwise stated in the contract, the contractor shall prepare a test plan in accordance with paragraphs 4.3(a) and 4.4(a) of MIL-T-28800, for use with both classes of inspection. The test plan shall include as a minimum the tests listed in TABLES I, II, & III, the tests noted in section 4.4, and a description of the satisfactory operation check and satisfactory operation test, as defined in para 4.5 of MIL-T-28800. Unless otherwise required, the tests and inspections to be performed shall be identical for both classes of inspection.

4.3.2 Inspection sampling plan. The inspection sampling to be performed during both classes of inspection shall be as specified in MIL-T-28800, except as indicated below:

4.3.2.1 Unless otherwise specified herein or in the contract, the Group C, D, E & F quality conformance inspections shall be performed on the first production lot only.

4.3.2.2 The Group D EMI tests and Group F Reliability test shall be performed during quality, conformance inspection only if not performed during first article or bid sampling testing.

4.4 Quality assurance tests. Unless otherwise specified herein, the following tests shall be performed in accordance with MIL-T-28800.

4.4.1 Electromagnetic interference. One equipment shall be subjected to an EMI test for compliance with the requirements of 3.9.1. All test set-ups and procedures shall comply with the measurement techniques of Notice 3, MIL-STD-462. All emission and susceptibility tests shall be performed with the output cable connected to, and extended parallel with, the front of the equipment. The output cable shall be terminated to simulate a normal loading configuration.

4.4.2 Humidity. The equipment shall be subjected to the humidity test specified in para 4.5.5.1.1.3 of MIL-T- 28800.

4.4.3 Vibration. The equipment shall be subjected to the vibration tests specified in MIL-T-28800 for Class 5 equipment, except that the equipment shall not be operated during the test. The satisfactory operation test shall be performed prior to and following vibration testing.

4.4.4 Reliability. The reliability tests shall be performed as follows:

4.4.4.1 Burn-in. Each deliverable equipment shall be subjected to a minimum 96 hours on-time burn-in period, prior to Group A testing. During the last 24 hours of burn-in, the equipment must operate failure free. Up until this time, equipment will be allowed to accumulate failures. Each equipment which fails during the final 24 hour period shall be repaired and returned to test until it successfully survives a 24 hour period

TABLE I

Examination and Test Groups

DESCRIPTION	REQUIREMENT	TEST METHOD
Group A Preoperational Inspection Leakage Current Level A Performance	4.5.3.1* 3.2.1.3.1* TABLE II	4.3.1
Group B Level B Performance	TABLE III	4.3.1
Group C Electrical Power Environmental Requirements Humidity Vibration	3.5 3.9 3.9.2 3.9.3	4.3.1
Group D Electromagnetic Interference	3.9.1	4.4.1
Group E Dimensions Weight Front Panel Marking	3.6.1 3.6.2 3.8	4.3.1 4.3.1
Group F Reliability	3.10	4.3.1, 4.4.4
*Paragraphs of MIL-T-28800.		

TABLE II

Level A Performance Tests\*

DESCRIPTION	REQUIREMENTS
Cable Measurement	3.11.1
Readout Method	3.11.2
Input/Output Impedance	3.11.3
Reflected Amplitude	3.11.4
Primary Connectors	3.11.5
*Level A Testing is Abbreviated Testing (see 6.4.1).	



TABLE III

Level B Performance Test

DESCRIPTION	REQUIREMENTS
Test Pulse	3.11.1.1
Test Pulse Amplitude	3.11.1.2
Scale Multiplier	3.11.1.3
Feet/Division Control	3.11.1.4
Cable Dielectric Scales (Vp/Vair)	3.11.1.5

without failure. Failures which occur during the burn-in test shall be noted and reported, but shall not count toward the establishment of equipment MTBF. Prior to burn-in, the satisfactory operation test of 4.3.1 shall be conducted. Daily satisfactory operation checks (4.3.1) shall be conducted. For the last 24 hour failure-free period, a complete satisfactory operation test shall be conducted prior to and after the period.

4.4.4.2 Reliability sampling plan.

4.4.4.2.1 First Article. The Group F reliability demonstration shall be conducted on at least five (5) samples. The use of ten (10) samples is encouraged, but not more than ten (10) samples shall be used.

4.4.4.2.2 Quality conformance inspection. The Group F reliability tests shall be performed on the first production lot only if not performed during First Article testing. From those units of the first lot that have passed the required Group A and B tests, a random sample of ten (10) units shall be selected for Group F testing.

4.4.4.2.3 Reliability test plan. The reliability tests shall be conducted in accordance with the following test plan:

$$\theta_0 = (\text{TBD})$$

Number of Failures	Accept** (Equal or More)	Total Test Time* Reject*** (Equal or Less)
0		
1		
2		
3	(TBD)	

\* Total test time is total unit hours of "equipment ON" time (in hours).

\*\* Accept if test time is greater than or equal to that listed.

\*\*\* Reject if test time is less than or equal to that listed.



Number of Failures	Accept** (Equal or More)	Total Test Time*
		Reject*** (Equal or Less)
4		
5		
6		****

- \* Total test time is total unit hours of "equipment ON" time (in hours).  
 \*\* Accept if test time is greater than or equal to that listed.  
 \*\*\* Reject if test time is less than or equal to that listed.  
 \*\*\*\* Reject if test time is strictly less than (TBD) with 6 failures.

4.4.4.3 Test length. Testing shall continue until the total unit hours together with the total count of relevant equipment failures permit either an accept or reject decision in accordance with the specified test plan. Only equipment "ON" time may be used in MTBF or longevity determinations. Testing shall be monitored in such a manner that the times to failure may be estimated with reasonable accuracy. No single equipment "ON" time shall be less than one-half the average operating time of all equipments "ON" test.

#### 4.4.4.4 Test conditions.

##### 4.4.4.4.1 Operating mode (duty cycle).

4.4.4.4.2 Test level. While under test, the equipment shall be subjected to the conditions specified by Test Level B, MIL-STD-781.

4.4.4.4.3 Input voltage cycling. When so directed by the procuring activity, voltage cycling shall be accomplished as follows: The input voltage shall be maintained at one hundred ten percent (110%) nominal voltage for one-third of the equipment "ON" cycle, at the nominal value for the second one-third of the equipment "ON" cycle, and at ninety percent (90%) for the final one-third of the equipment "ON" cycle. This cycling procedure is to be repeated continuously throughout the reliability test.

4.4.4.5 Reliability examination and test method. The following inspections shall be used to verify equipment operation during reliability testing. The satisfactory operation test of 4.3.1 shall be used to confirm proper equipment operation prior to and following reliability testing. The satisfactory operation test shall also be performed weekly to verify equipment operation. The satisfactory operation check of 4.3.1 shall be used to monitor proper operation of the equipment daily.

4.4.4.6 Reliability failure actions, Group F. In the event of failure(s) during reliability testing, failure action shall be taken as required in MIL-STD-781B.

4.4.4.7 Corrective action, Group F. In the event the reliability test reaches a reject decision, corrective action shall be taken as required in MIL-STD-781B.

4.4.5 Optional quality assurance system. The procuring activity may substitute tests from a Department of Defense (DoD) approved supplier's quality assurance system for any or all tests in TABLE I.

## 5. PACKAGING

5.1 Preservation, packaging. Packaging for delivery shall be in accordance with MIL-T-28800 and as specified by the procuring activity.

## 6. NOTES

6.1 Intended use. The equipment is intended for use in maintaining electronic communications equipment by equipment repair units in intermediate and depot maintenance.

6.1.1 Equipment replaced. Equipment procured according to this specification is intended to replace all versions of various older equipments now fielded. These equipments to be replaced are listed below: (TBD)

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification and any amendment thereto
- b. Packaging requirements (see Section 5)
- c. When rough handling and functional tests are required
- d. Place of final inspection
- e. Technical literature required
- f. Quantity of tools and running spare parts required
- g. Marking for shipment and shipping containers
- h. Test plans and test reports
- i. Classification of inspection and number of samples required
- j. Rack mounting requirements
- k. Alternate power requirements
- l. Maintainability rationale
- m. Reliability rationale

6.3 Contract data requirements.

- a. Nomenclature assignment
- b. National stock number
- c. Equipment sample test plans
- d. Pretest performance records
- e. First production test data
- f. Identification plate drawing

6.4 Definitions.

6.4.1 Level A performance tests. Level A testing (TABLE II) is a reduced amount of testing which is performed on each equipment produced. Its purpose is to insure that all functions and modes of operation of the equipment



are evaluated without extensively checking each parameter as required in the Level B test (TABLE III). The approved equipment test procedure shall specify the actual amount of testing to be performed.

**6.4.2 Reliability rationale.** Reliability rationale submitted with the bid should provide clear and concise rationale showing how the reliability of the equipment complies with minimum requirements of the solicitation. This may include data from previous reliability tests, reliability predictions and other data available to the offeror. In the absence of such data on the equipment being offered, such data on similar equipment of equal or greater complexity produced by the offeror may be submitted. However, such data must be clearly identified as comparative data, and accompanied with specifications and technical literature on the similar equipment. The acceptance of the submitted rationale does not relieve the successful bidder of performing and successfully completing the production reliability testing.

**6.4.3 Maintainability rationale.** Maintainability rationale submitted with the bid should provide clear and concise rationale showing how the maintainability of the equipment complies with requirements of the solicitation. This may include data from previous maintainability tests, records of repair and calibration data, and other data on the equipment available to the offeror. Data on selection of module size and other design features relevant to maintainability may also be submitted.

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